Bridging the “valley of death”: improving the commercialisation of research

Response to the House of Commons Science and Technology Select Committee Bridging the “valley of death”: improving the commercialisation of research inquiry from *Engineering the Future*. This report has been developed in collaboration by the following institutions:

- The Royal Academy of Engineering
- The Institution of Chemical Engineers
- The Institution of Engineering and Technology
- EngineeringUK

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Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK’s 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

Introduction

A growing recognition exists within government, industry and the media that the UK needs to 'rebalance' its economy, moving the emphasis towards capturing value from wealth-creating products and services and away from 'financial engineering'. Recent government policies and announcements explicitly recognise the need for economic recovery based on high-value, high-technology manufacturing. Ensuring that the UK industrial system is able to capture value from products and services based on high-value and high-technology manufacturing requires constant innovation and commercialisation of new products, services and business processes to maintain a competitive advantage.

Innovation is not a simple linear process – it requires feedback from the market and timely investment at critical points of development. The 'valley of death' is used to describe that period in the development of a product or service when a significant increase in investment is required, making the risk of failure much more likely to outweigh any potential future return. It can occur in a wholly commercial organisation as well as in the context of commercialising university research and new, nascent, technologies.

The 'valley of death' is not necessarily an intrinsically bad thing. One of the things it does is act as a filter, taking out poorly conceived propositions. Any change in policy to support the commercialisation of products, services and processes must be wary of artificially prolonging the lifetime of those weaker ideas.

The problem with the strict economic approach to the investment process is that strategic priorities can be overlooked. Processes to overcome the 'valley of death' must be employed where products and services are strategically fundamental to a business or provide sovereign capability to the UK. Without a long term approach to maintain capability via the implementation of innovation into product development can and has resulted in a leading position in a business sector being lost. The key is to identify those technologies where bridging the 'valley of death' is essential and those where a 'fast follower approach' is sufficient. The role of the TSB to provide a focus for long term capability investment is vital.

1. What are the difficulties of funding the commercialisation of research, and how can they be overcome?

1.1 New and established companies are still having difficulties in accessing working capital from banks on appropriate terms. Overly stringent restrictions have remained in place despite much political comment. Government should be using its position as the main shareholder in largely taxpayer-owned banks to enforce a change in behaviour and increase lending to companies. The Business Growth Fund (BGF) is a new venture where the government has formed a consortium of banks that are providing cash supported by government guarantees. The target is to support rapid growth of selected SMEs in the annual revenue range £10 million to £100 million. However, this is a new scheme and we await take-up and outcomes. The BGF consortium model could possibly be extended to earlier innovation phases and including venture capital and private equity houses alongside banks. The government has put into place measures such as the Enterprise Investment Schemes (EIS) to support the commercialisation of research. EIS helps smaller high-risk companies and established SMEs find funding by stimulating investment via tax-incentives. It is important for government to continue to proactively publicise the scheme to ensure that the SME community is aware of it. Government should also ensure that, in line with its approach to reducing bureaucracy, that schemes for SMEs are not overly bureaucratic or burdensome which could then create a disincentive to engagement.

1.2 Capital is available from UK venture capital funds and private equity, but is usually short-term in nature. Short-term thinking also means investors start looking for the exit route from a spin-out company at the time of creation, and do not think about growing it into a large organisation. This has dissuaded investors from supporting innovative research, which often takes much longer to return a profit. Another reason for this attitude among investors is a lack of understanding of engineering propositions, and the timeframes needed to develop and establish these types of businesses.

1.3 A closer relationship between universities and business should be developed to increase the amount of successfully commercialised research. Open innovation, "combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies"[i], is encouraging collaboration between universities and industry. Catapult Centres and Local Enterprise Partnerships will play an important role here. They can effectively reduce investment capital requirements for companies entering certain markets by offering open access prototyping, scale-up and demonstration facilities. Catapults will also form a hub for useful multi-company and university consortium activity. Government should continue to show support for carefully chosen growth sectors where a comparative international advantage exists. This has been done in the recently published Strategy for UK Life Sciences. These interventions show long term support for these areas from government and give confidence to investors. Professional engineering organisations will also continue to act as a conduit between business and academia, bringing parties together through events, projects, awards and funding.

1.4 The management of companies spun out from universities is also a challenge when commercialising research. Different universities operate different technology transfer models. Universities new to commercialising research can tend to believe that ownership of the IP is vital. They encourage academics to form as many companies as they can, in which the university holds equity and owns IP. Companies set up in this environment can sometimes be ill-conceived and poorly managed. Universities with more experience may come to recognise that ownership of IP is not as important as value gained through exploitation. Where a company owns the initial IP, and the university is one of the shareholders, the company is free to act as it wishes guided by commercial principle. Allowing organisations independent of universities to bid to run spin-out companies could also reduce the fail-rate.

1.5 Both in the UK and in Europe, there is a political perception that innovation and rebalancing of the economy will be driven by the private sector with a significant contribution from SMEs, which may be somewhat optimistic. Larger established companies are the traction engine that pulls through smaller companies in their supply network. They should be equally encouraged and supported to commercialise research, both in their own right and in concert with SMEs and their own supply network companies.

2. Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?

2.1 The globalised nature of business now means that the choice of where to develop and manufacture products is strategically and commercially very important. For example, in the past, the UK had a strong electronics manufacturing base, but this has now largely shifted to the Far East, where the costs, skills and fiscal regimes are more attractive. The tax havens and investment grants offered by countries such as Singapore have also exerted a powerful pull on the pharmaceutical industry. In this context, UK companies need to be strategic in their decisions and ensure they remain in control of value of production, even if the products are manufactured elsewhere.

2.2 The quality of the supply network in the UK can hinder the commercialisation of research in some sectors. For example, the chemical process industry and chemical engineering have a highly fragmented supply network, in many cases international in nature, and with a multitude of products, processes, roadmaps and innovation processes. These characteristics make it very difficult to implement innovative supply networks. Another example is batteries, fuel cells and hydrogen storage products, which cannot be manufactured in the UK as there are few, if any companies able to operate to scale up production of materials. Inevitably the exploitation at scale must be done elsewhere.

2.3 In sharp contrast to this are the automotive and aerospace industries where dominant OEMs actively encourage innovative supply networks to form, because they know that a quality supply network is a comparative advantage for the business. The innovations in the automotive industry are offering something of a renaissance opportunity for the UK where the legacy in automotive and involvement in motorsport has established a skills base.

2.4 A lack of understanding by investors of the technologies and regulatory environment can also be a hindrance to the commercialisation of research in some sectors. Large scale process applications tend to need plenty of capital investment and often require stringent regulatory constraints and approvals to be satisfied. In this environment, it is hard to envisage a succession of small start-ups. Rather than trying to secure start-up funding, smaller companies in sectors like this could approach larger companies and offer to licence their IP to them.

3. What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?

3.1 Many instances exist of UK-based research having been transferred outside the UK for commercialisation. Factors may include: favourable tax regimes, better funding opportunities, less government bureaucracy or availability of a skilled workforce. However, a critical issue is where the value of production is captured, which may not devolve to the country or region where products are made. For example, ARM designs and licenses out intellectual property (IP) rather than manufacturing and selling chips. It is an extremely profitable and rapidly growing business with profit before tax for 2011 up 37% on the profit forecast to £230m.

3.2 An example of a company choosing to manufacture abroad that will be well known to the committee is Plastic Logic[ii]. When considering manufacturing bases, three sites were shortlisted, Dresden, Singapore and New York State, and judged on:

- access to local grant support and prospects for low operating costs;
- speed of the process from outline agreement to site hand-over;
- access to a skilled workforce.

3.3 Dresden was the winner, because it had an excellent skills base and there was clear support for manufacturing through the German network of Fraunhofer Institutes. Although there is access to both these advantages in the UK, planning and construction timescales in the UK are not competitive, particularly in the more economically successful parts of the country.

3.4 Other companies that have previously tried to base manufacturing in the UK have moved manufacture abroad. Cambridge-based charity Raspberry Pi had to revise their plans to manufacture their low-cost computers in the UK mainly due to prohibitive taxation[iii]. The organisation blamed a lack of UK competitiveness as well as HM Revenue and Customs for their decision to manufacture in Taiwan and China.

3.5 Further anecdotal examples of companies commercialising abroad exist. Ilika is a materials discovery business using technology developed at the University of Southampton from EPSRC funding. No adequate UK suppliers could be found to scale up the novel hydrogen storage materials and so it is being done in the US. Another reason for commercialising abroad was that no UK end user for the material existed.

3.6 To ensure the value of production stays within the UK, the government should develop an integrated strategy which differentiates it from other economic centres. A joined up approach includes the following elements: a strong research base, a skilled and flexible workforce, an effectively integrated supply network culture, supportive and stable government policy, a tax regime proven to encourage innovation and its commercialisation and a supported R&D infrastructure from the new Catapult network, other TSB initiatives and greater collaboration between universities and business.

4. What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?

4.1 This is a question that the committee should pursue in more depth with the Secretary of State and the TSB itself.

4.2 The *Engineering the Future* partners are supportive of the TSB. Commercialisation of products and services is a long-term endeavour. As an organisation, TSB has been in existence for four years, the Small Business Research Initiative (SBRI) started in 2001 and the first Catapult centres have only just been created. In relation to schemes such as SBRI, there have been examples in other countries notably the Small Business Innovation Research (SBIR) scheme in the US, where there has been considerable success in supporting SME growth through public procurement[iv]. The TSB, SBRI and Catapult centres should be given more time and resource to embed themselves properly into the specific technology areas they have decided to support and develop their delivery practices before a full evaluation of their impact can take place.

5. What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?

5.1 Among the developed European nations, the UK is unusual in that it has not historically supported 'intermediate institutes' of any significance and certainly not on the scale of the Fraunhofer Institutes (Germany), TNO (Netherlands) or VTT (Finland). Instead, the UK placed greater emphasis on university research with mixed results for the nation's innovation performance. The creation of the TSB Catapult centres, following the announcement of a £200m innovation programme in 2010, was a welcome development. The TSB could also coordinate a strategic programme to support and strengthen the supply networks.

5.2 At the SME end of the scale, innovation vouchers aim to encourage small firms to experience a low cost, low risk taster of working with a university or an R&D organisation. The scheme now operates nationally and a further tranche is expected in 2012. This scheme should be carefully monitored and, if successful, maintained and expanded.

5.3 Annual reporting of R&D expenditure should be encouraged. It is regrettable that BIS chose to withdraw funding from the well respected and widely used R&D Scoreboard in 2010. As a measurement of innovation, knowing the amounts of funding is of limited use, but without the Scoreboard there is no way of comparing R&D spend across the full range of industry sectors.

6. Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?

6.1 The UK should be encouraging more private equity investment. The key to achieving this is to make the UK an attractive area to invest in. Countries such as the USA, Germany, Switzerland, France, Singapore and China have a much clearer and better defined landscape that is understood by business. The UK is not clear on what the strategy is to support the rebalanced economy. A much sharper, distinctive and consistent narrative needs to be developed to highlight our innovative, entrepreneurial and commercial spirit grounded on excellent science and engineering.

6.2 Existing government strategies (such as the new BIS Innovation and Research Strategy) point broadly in the right direction, but often lack sufficient resources behind them to make a real impact. Government can improve this by continuing to support and increasing the funding behind the work of the TSB and the work they do. Schemes such as the Enterprise Investment Scheme should be more widely advertised in order to further stimulate "Active Angels". The government could also consider launching an Innovation fund, as described in our answer to question 1.

6.3 A high level of technology ignorance exists within some sectors of the funding market. The engineering profession has been working to bridge this gap and should be supported in continuing to do this. For example, The Royal Academy of Engineering provides:

- Engineering Enterprise fellowships, enabling researchers to spend 12 months commercialising their research with the help of business mentors and access to business angels;

- ERA Foundation Entrepreneurs' Award, established to identify entrepreneurial researchers, working in UK universities, in the field of electro-technology, who are at an early stage in their career.

6.4 Regulators also have a role to play in some sectors. They should examine the need for capability development and retention beyond the requirements of their license and authorisation conditions. This would encourage further investment from outside sources.

7. What other types of investment or support should the Government develop?

7.1 There can be no innovation and growth without the skills base to drive it. With this in mind the government should:

- maintain investment in engineering undergraduate education;
- take steps to encourage companies to invest in training (such as tax breaks on training costs);
- facilitate easier take up of visa rules for STEM academia and those who bring both learning and experience (such as chartered professionals including chartered engineers);
- continue to reduce bureaucracy around apprenticeships;
- provide loans for postgraduate study.

7.2 Universities and industry should be encouraged to cooperate. Incentives to encourage individual academics and universities to undertake high quality industry outreach, both on a national and international level, as well as academic research could be created through the REF scheme. The Wilson Review of university-business collaboration may provide further guidance on this. Universities should also be encouraged to cooperate rather than compete with each other, both within the UK and internationally. The recent announcement to exempt universities from VAT on shared services is a strong signal of support from government in this area.

7.3 Government can also encourage innovation further in the UK by:

- acting as a smart customer, driving innovation through procurement;
- strengthening UKTI's capability in engineering and science;
- negotiating trade agreements that include collaboration and innovation;
- creating a regulatory environment that can encourage innovation.

7.4 Companies should be encouraged to base their R&D activities within the UK. Putting into place tax and funding policies that have been successfully shown to support R&D activities within companies would encourage this. The NESTA supported study *Innovation: what works?* may provide some guidance in this area. Additional benefits to companies beyond R&D tax credits should also be examined where re-investment is towards UK infrastructure and academia. Bodies offering funding for R&D should have simple, transparent and fast response administrative processes for grant applications. Grant funding and tax relief facilities should also be continuously available, with no artificial deadlines for applications. Multinational companies headquartered in the UK should also be allowed to offer secure career paths to top talent from overseas.

7.5 Government should also continue to support the work of the engineering professional bodies to promote engineering within the UK. These bodies work to bring people from industry and academia together and also by recognising companies and individuals that have contributed to innovation in the UK by means of award schemes. They also provide funding for researchers keen to commercialise research. Initiatives which raise the profile of engineering within the UK, such as the Queen Elizabeth Prize for Engineering, Tomorrow's Engineers, The Big Bang Fair and I'm an Engineer, get me out of here! should also continue to be supported.

[i] http://www.openinnovation.eu/open-innovation/
[ii] http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/50/50i.pdf
[iii] http://www.zdnet.co.uk/news/emerging-tech/2012/01/11/raspberry-pi-enters-production-but-not-in-uk-40094792/
[iv] http://www.nesta.org.uk/publications/reports/assets/features/buying_power